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UPPER SACRAMENTO RIVER SPORT FISHERY

By

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INTRODUCTION

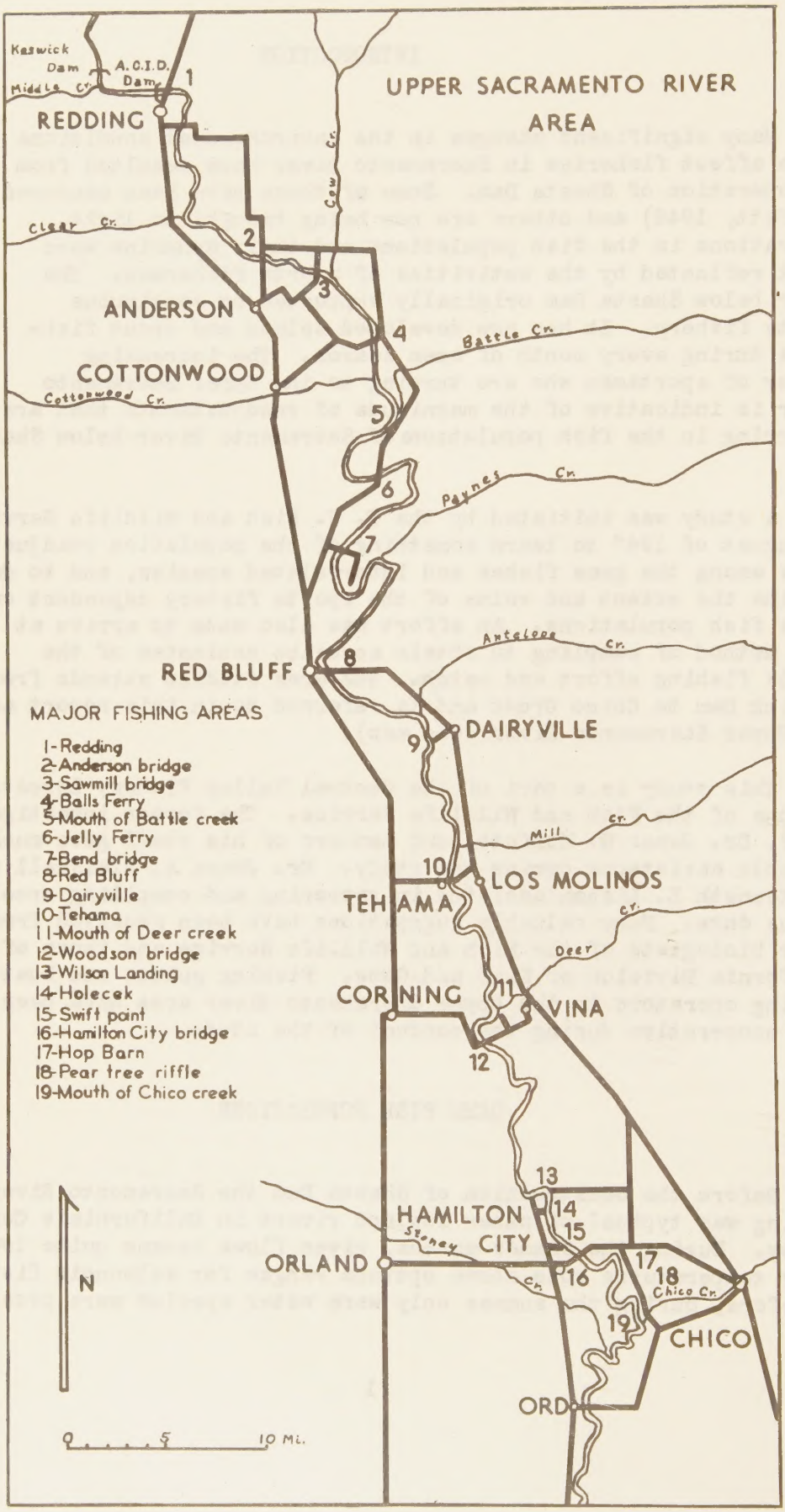
Many significant changes in the environmental conditions which affect fisheries in Sacramento River have resulted from the operation of Shasta Dam. Some of these have been measured (Moffett, 1949) and others are now being brought to light. Alterations in the fish populations and their dynamics were first reflected by the activities of sports fishermen. The river below Shasta Dam originally supported no continuous sports fishery. It has now developed salmon and trout fisheries during every month of open season. The increasing number of sportsmen who are turning to the Upper Sacramento River is indicative of the magnitude of readjustments that are occurring in the fish populations of Sacramento River below Shasta Dam.

A study was initiated by the U. S. Fish and Wildlife Service in August of 1947 to learn something of the population readjustments among the game fishes and interrelated species, and to determine the extent and value of the sports fishery dependent on these fish populations. An effort was also made to arrive at some method of sampling to obtain accurate estimates of the sports fishing effort and catch. The area studied extends from Keswick Dam to Chico Creek and is referred to in this report as the Upper Sacramento River (see map).

This study is a part of the Central Valley Fishery Investigations of the Fish and Wildlife Service. The former investigation chief, Dr. James W. Moffett, and members of his staff gave much valuable assistance during the study. Mr. James A. Blaisdell and Mr. Kenneth L. Liscom assisted in gathering and compiling creel census data. Many valuable suggestions have been received from other biologists of the Fish and Wildlife Service and those of the California Division of Fish and Game. Fishing guides and boat landing operators in the Upper Sacramento River area have been very cooperative during the conduct of the study.

GAME FISH POPULATIONS

Before the construction of Shasta Dam the Sacramento River below Redding was typical of other lowland rivers in California's Central Valley. During the summer months, river flows became quite low and water temperatures rose above optimum ranges for salmonoid fishes. Therefore, during the summer only warm water species were present.


UPPER SACRAMENTO RIVER AREA
Keswick Dam
A.C.I.D. Dam
Middle Cr.
REDDING
Clear Cr.
Cow Cr.
ANDERSON
COTTONWOOD
Cottonwood Cr.
Battle Cr.
Paynes Cr.
Antelope Cr.
RED BLUFF
DAIRYVILLE
Mill Cr.
LOS MOLINOS
TEHAMA
Deer Cr.
CORNING
VINA
HAMILTON CITY
Stoney Cr.
ORLAND
Chico Cr.
CHICO
ORD
MAJOR FISHING AREAS
1-Redding
2-Anderson bridge
3-Sawmill bridge
4-Balls Ferry
5-Mouth of Battle creek
6-Jelly Ferry
7-Bend bridge
8-Red Bluff
9-Dairyville
10-Tehama
11-Mouth of Deer creek
12-Woodson bridge
13-Wilson Landing
14-Holecek
15-Swift point
16-Hamilton City bridge
17-Hop Barn
18-Pear tree riffle
19-Mouth of Chico creek
N
0 5 10 Mi.

It is believed that the most common game fish during the pre-Shasta Dam period were the striped bass, Roccus saxatilis, and a species of catfish, probably Ictalurus catus. Species of lesser importance to the sports fishery of that period included largemouth bass, Micropterus salmoides; bluegill, Lepomis macrochirus; Sacramento perch, Archoplites interruptus; shad, Alosa sapidissima; Sacramento sucker, Catostomus occidentalis; carp, Cyprinus carpio; and Sacramento squawfish, Ptychocheilus grandis.

King salmon, Oncorhynchus tshawytscha and steelhead trout, Salmo gairdneri, were available to the Sacramento River sports fishery only during their spawning migrations in the fall, winter, and early spring months. The contribution made by salmon to the sports fishery cannot be accurately determined. Tales about the salmon fishery do not agree, probably because of variable populations and unstable conditions influencing its distribution. The steelhead trout fishery was quite constant, starting late in the fall and continuing until the season's end on the last day of February.

Following the construction of Shasta Dam, the Sacramento River below it was altered considerably. The 50-degree water from sub-thermocline depths and the increased summer flows released from Shasta Reservoir produced conditions in the Upper Sacramento River suitable for salmonoid fishes during all months of the year.

Adult king salmon are present in the Upper Sacramento River in every month of the year. They are most abundant during spring, summer, and fall. Young salmon are also year-round residents in this section of the river. A variable portion of each season's hatch remains in the river until the second spring after hatching before moving downstream to the ocean.

Early spring migrations of steelhead trout and many steelhead that migrated into the drainage to spawn during the previous winter find the river environment favorable and remain there into summer. These fish take on rainbow trout color characteristics and, together with resident rainbows, constitute a year-round trout population.

Local anglers believe that striped bass are not as abundant in the Upper Sacramento River as they were prior to the construction of Shasta Dam. The full significance of this change is yet to be learned, but it is possible that altered river conditions have resulted in modifications of the migratory habits of striped bass in this area.

Catfish and carp have become less abundant in the Upper Sacramento River but are still common in slough areas. These fish are also found in the lower reaches of tributaries entering the Sacramento River. The Sacramento sucker and squawfish have thrived and multiplied under conditions produced by Shasta Dam and are now represented by relatively dense populations distributed over the entire upper river. Shad are still found

in the upper river area during their spring spawning migration (May - July). A species new to the Upper Sacramento River, the smallmouth bass, Micropterus dolomieu, has appeared in small numbers in areas where it was not known before. Largemouth bass are still found in slough areas but are rarely taken from the river.

SPORTS FISHERIES

King salmon and rainbow-steelhead trout make the greatest contribution to the sports fishery of the Upper Sacramento River. Other species entering the sports fishery, in order of their importance, are striped bass, catfish, shad, Sacramento squawfish, Sacramento sucker, carp, smallmouth bass and largemouth bass.

The fishing gear generally used in the salmon fishery is a medium or heavy rod, reel, line and leader equipped with any one of a number of wriggling, undulating or spinning lures. Lures most commonly used are spinners, plugs and flatfish of various sizes, finishes and forms. All types of lures seem to provide good results as long as they are bright and display action while moving through the water.

Four distinct types of salmon fishing found on the Upper Sacramento River are: boat fishing, bridge drifting, bank casting and riffle casting.

Boat fishing is the most widely distributed fishing method. Boat fishermen usually tow fishing lures through pool areas or anchor in water sufficiently swift to activate their lures. Bridge drifting is similar to boat troll fishing except that the current of the river, rather than motion of the boat, is always relied upon to hold the line taut and activate the lure. This method became so popular that most bridges have been closed to fishing as a safety measure. Bank casting takes place along the river where ledges border deep holes. Riffle casting is engaged in only during the spawning period, when the fishermen work shallow riffles where salmon are spawning.

Rainbow (resident) and steelhead (sea-run) trout fisheries are treated as one in this study. Both varieties are taken by the same fishing methods at the same time, and are often indistinguishable. Trout fishermen most frequently use salmon eggs, fresh or preserved, both single and in clusters, as bait. Angle worms, flatfish, spinners and artificial flies are used less frequently in the order named.

Striped bass make the most important contribution to the minor game fisheries of the Upper Sacramento. Fishing for striped bass above Red Bluff is infrequent with but few catches reported as far north as the Anderson area. From Red Bluff downstream the striped bass fishery becomes more important. It constitutes the major sports fishery in the area west of Chico during the summer months.

Catfish provide a minor sports fishery during all months of the year. Most of these fish are taken near sloughs formed by old river channels. A bump-net (a form of a dip net) fishery for shad occurs from May into July. Many shad are also taken by salmon fishermen during this period. Sacramento squawfish, carp and the Sacramento sucker are most often taken incidental to trout, striped bass and catfish fishing. A very few smallmouth and largemouth bass are taken incidental to salmon fishing.

CREEL CENSUS METHODS

The initial phase of the creel census covered the period from September 1947 through February 1948. In addition to the collection of creel census data during this period, various means of obtaining an adequate sample of the fishing effort were explored. The river between Redding and Hamilton City was divided into four sections: Redding to Balls Ferry, Balls Ferry to Red Bluff, Red Bluff to Woodson Bridge, and Woodson Bridge to the Hamilton City area. One section was toured each day and the coverage was rotated so that during an 8-week period each section was covered twice on Fridays, Saturdays, and Sundays, and once on each of the remaining days of the week.

After November 1947 and through February 1948 the creel-census study area was expanded to include the 106 river miles between Middle Creek, the upper limit of fishing near Redding, and Chico Creek which marks the lower limit of concentrated fishing. This area was divided into two sections, one above and one below Red Bluff, of 54 and 52 river miles respectively. Each section was covered on alternate Saturdays, Sundays and one weekday each week. It was learned that fishing pressure on Friday did not differ from that on other weekdays.

Results of the 1947-48 study led to a change in the census procedure used during the fishing season May 1, 1948, through February 1949. Coverage of the sections was made in a scheduled pattern as shown in Table 1. Following this schedule, each section was covered every Saturday and Sunday, with the sections covered alternately in morning and afternoon in succeeding weeks. A schedule for other days was so arranged that each section was covered one day each week, thus coverage of an individual section was made once for each weekday in a 5-week period.

Table I

Creel Census Sampling Schedule

Week	Day of Week						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First	Axa Byp	Bxa	Ayp				Axa Byp
Second	Bxa Ayp		Byp	Axa			Bxa Ayp
Third	Aya Bxp			Bya	Axp		Aya Bxp
Fourth	Bya Axp				Bxp	Aya	Bya Axp
Fifth	Axa Byp	Ayp				Bxa	Axa Byp

A = Section A, Middle Creek to Red Bluff

B = Section B, Red Bluff to Chico Creek

x = Coverage from north to south

y = Coverage from south to north

a = Coverage in morning period

p = Coverage in afternoon period.

The census day extended from the time in the morning before the first anglers stopped fishing until the time in the evening after which no anglers started fishing. This period was determined from continuous observations of the fishermen's habits and was changed each month. A census tour of one section was completed in half of this period. Census tours were made in accordance with a prearranged time schedule to provide uniform coverage of the fishing locations. The last fishing location was reached at the end of the census day. The creel census at that point continued until the last angler had stopped fishing, in order to obtain information regarding complete fishing efforts.

The land bordering the Upper Sacramento River is sparsely settled and access to the river is restricted to locations where roads either cross or come close. Consequently these locations are the major fishing areas (see map) and are referred to in this report as census stations.

A record was made of all fishermen at each station at the time of a visit. This constituted what is referred to in a latter section as a sample. Information gathered from fishermen who could be contacted included species sought, catch, time fished, method of fishing, origin of travel, number of anglers in the party and whether or not they had completed their fishing effort. The term "fishing effort," as used in this report, refers to the time an angler spends in the actual act of fishing during one legal fishing day (1 hour before sunrise until 1 hour after sunset). This information was recorded on the creel census form shown in Table 2. The number of fishermen and fishing parties that could be seen but not contacted was recorded under "Indirect Census." In virtually all cases it was possible to determine the species sought by these anglers from their location and type of fishing gear used.

Due to the size of the area and the presence of many inaccessible fishing locations between census stations, it was not possible to make a census of all fishermen by the above method. The number of fishermen escaping census was determined by airplane surveys in which all fishermen were counted and recorded as being either at or between census stations. Airplane counts were made at least once a month if flying conditions permitted.

Seven fishermen's registers were established at commercial boat rentals throughout the study area. The registers were placed in stands provided with spring scales so the angler could weigh his catch. The irregular use of registers made them a poor tool in determining the catch at any location. The entries did, however, provide valuable information about the weight of fish taken. It was possible to get reliable weights of salmon only from these records. Smaller individuals of species could not be weighed accurately on the scales provided.

Table 2

Front

CREEL CENSUS FORM

Station_____ Date_____, 19__ Time_____

Number in Party	Origin of Travel	Time Fished	Compl. Effort	Inc.	Shore	Boat	Bridge	Salmon	Trout	S. Bass	Cat.	Size of Fish

Back

Indirect Census

Species	Fishermen Seen: Parties	Fishermen Seen: Fishermen	Parties Seen
Salmon			
Trout			
Striped Bass			

PC - Parties contacted
FC - Fishermen "
HF - Hours fished
C - Catch
EC - Efforts complete
HC - Hrs. of compl. effort
MT - Miles traveled
P - Parties
M - Miles
FS - Fishermen seen
FC&S - " contacted & seen
PS - Parties seen

Summary

Species	PC	FC	HF	C	EC	HC	Mt: P	Mt: M	FS	FC&S	PS
Salmon											
Trout											
Striped Bass											
Catfish											

Notes: _____

An intensive creel census was made twice each week at various stations from May through August, 1948. This census involved checking all fishermen at the station for the entire legal fishing day. The method was abandoned, however, when it was discovered that equally or more reliable information about the hourly distribution of fishing effort could be obtained from the usual census methods. A comparison of these two methods is presented in Figure 1.

METHOD OF ANALYSIS

All data gathered for each species entering the fishery were summarized and analyzed separately by months for each of the two sections of the area studied. (See Appendix Tables 1A, 2A, 3A and 4A). Monthly intervals were chosen because local regulations and seasons are set at the start or end of various months. Analysis by sections allows for characteristics peculiar to each section to be represented in the results.

The 1947-48 creel census samples were smaller and less adequate than those of the following season, and for this reason, methods of analysis varied slightly, although the principles involved were the same as described below.

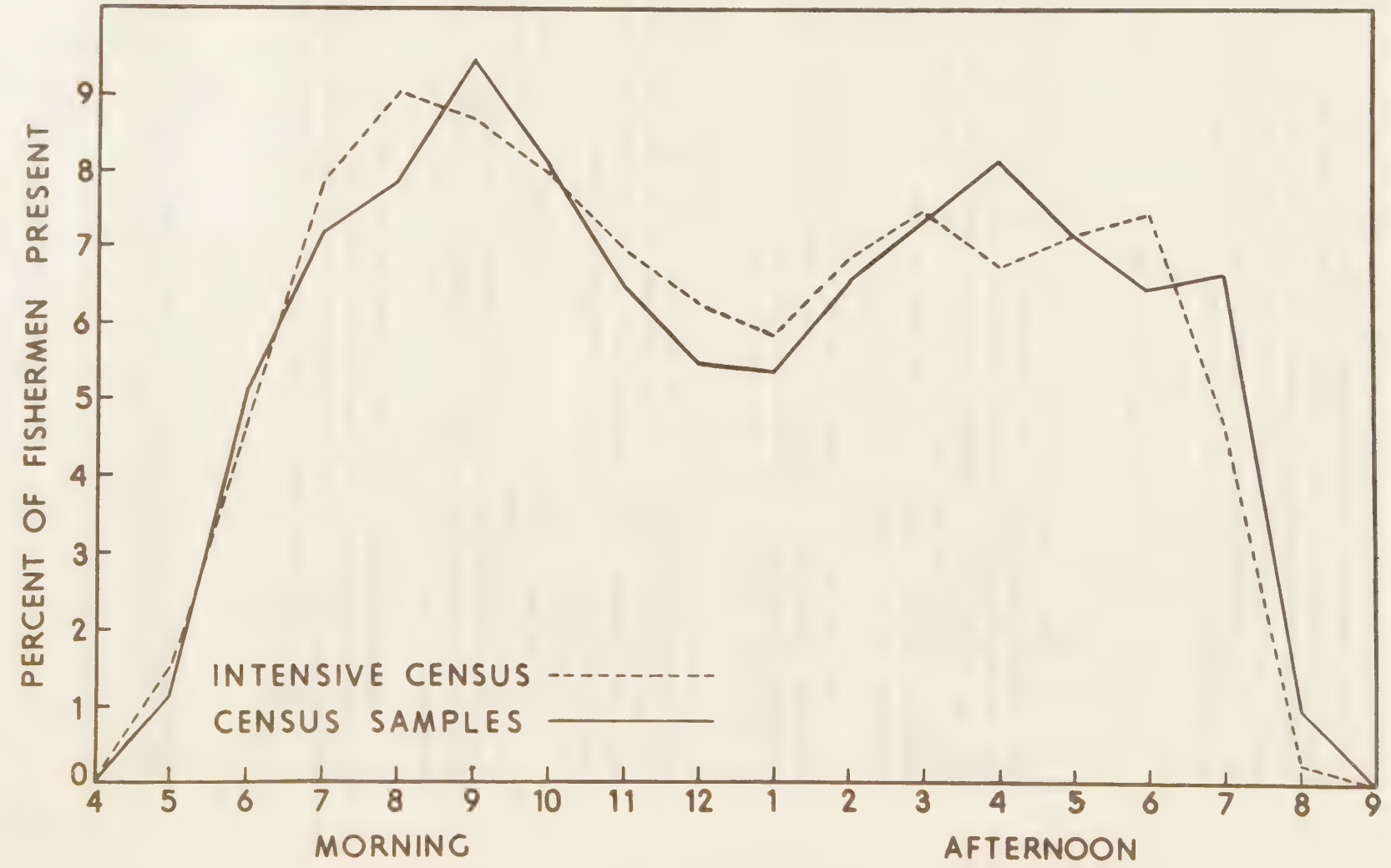
The analysis of creel census data to determine the total amount of fishing and total catch was divided into the following major steps; (1) determine the number of individual fishermen in samples, (2) obtain the total number of fishermen represented by samples, and (3) determine the total hours of fishing and the total catch.

It was necessary to estimate the number of fishermen in a sample in cases where fishing parties were enumerated but the number of anglers in each could not accurately be counted. The number of fishermen in these parties was calculated by applying the fishermen-per-party factor obtained from fishing parties of known composition.

Samples occasionally were missed on a Saturday or Sunday and regularly missed on weekdays. To expedite analysis, the samples were increased proportionally to represent as many Saturdays, Sundays or weekdays 1/ as occurred in the month of analysis, (see Appendix Tables IB, IIB, IIIB, and IVB).

1/ The preliminary surveys of 1947 revealed that fishing is the same on all weekdays but varies in intensity on Saturdays and Sundays.

Figure 1.-- Comparison of the hourly distribution of fishing effort for August, 1947, from analyses of 229 complete fishing efforts recorded by intensive census and 233 complete fishing efforts recorded by census sampling. Curves are made comparable by reducing to percentages. A very similar distribution curve was shown by fishermen of Fife Lake, Michigan (Eschmeyer, 1935).



The next step of analysis was to determine the portion of the whole represented by the fishermen sampled. To accomplish this a representative distribution of fishing intensity throughout the day was set up, using complete efforts recorded in census sampling (see discussion on page 9). The complete efforts were plotted graphically as shown in the hypothetical example in Table 3. In this case a person making a census of this fishing area once each hour during the census day (see definition on page 7) from 6 A.M. to 7 P.M. would have recorded 98 fishermen. The census covered a period of 14 hours, thus an average of 7 fishermen were present per hour. Since 25 individuals were involved it can be determined that 28 percent of the individual fishermen were present per hour (7 / 25 X 100 = 28) (see Appendix Tables I C, II C, III C, and IV C).

Because no two census samples of this survey were taken at the same location during any one day, the same individuals were not counted twice. Thus the total number of fishermen recorded could be considered as the average for the area or, in the above example, they would represent 28 percent of the total number of individual fishermen in the area covered by the census. The number of fishermen recorded could thus be adjusted to obtain the total number of fishermen at census stations.

The regular airplane surveys previously described revealed the percentage of fishermen at census stations (see Appendix Tables I D and II D). The number of fishermen at census stations was adjusted accordingly to obtain the total number of fishermen in the area surveyed.

Total number of hours of fishing during the period of analysis was determined by multiplying total number of fishermen by the average length in hours of a completed fishing effort for that period. The total catch was obtained by multiplying total number of hours by the catch per hour of the period of analysis (see Appendix Tables II E, III D and IV D).

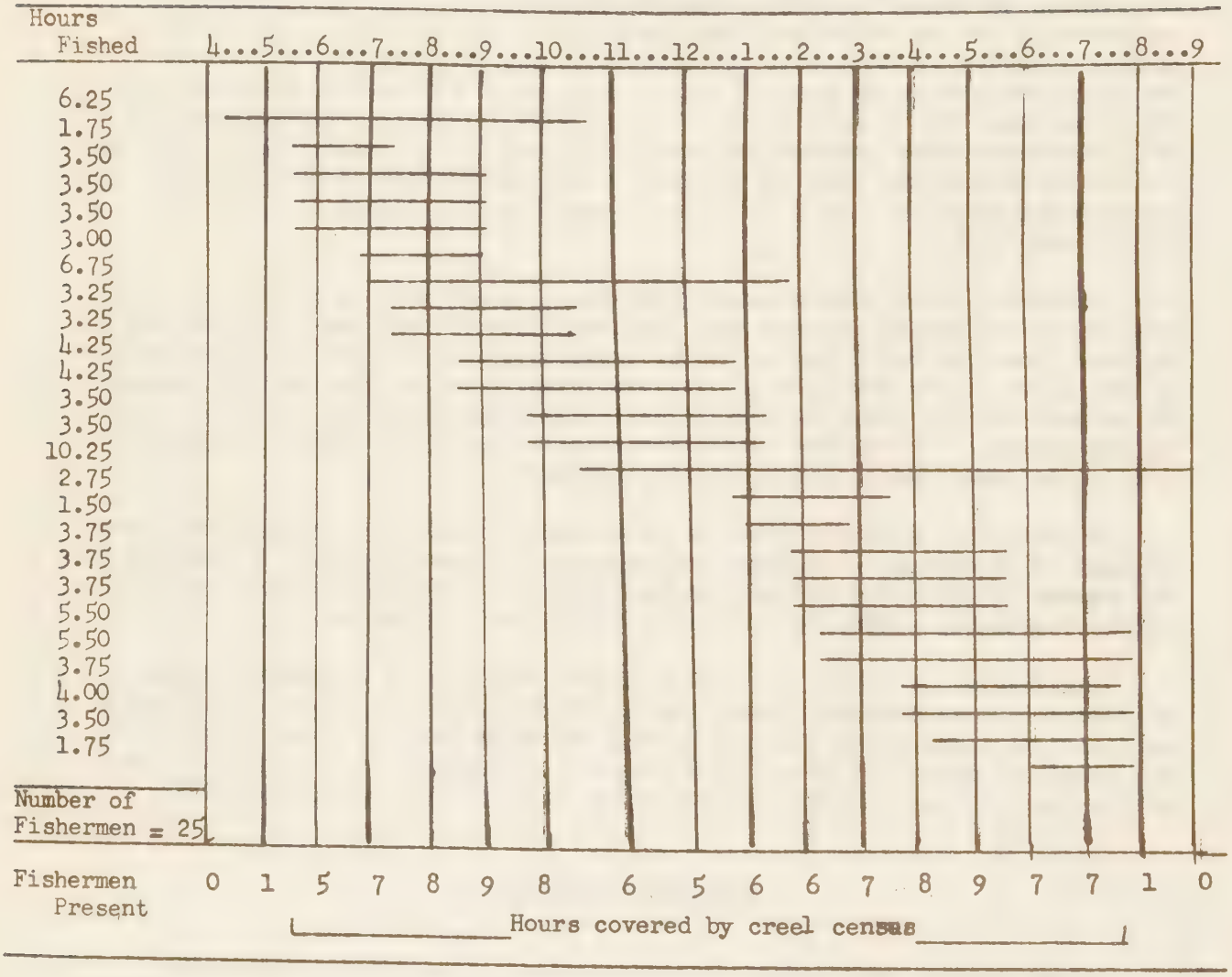
King Salmon Fishery

Creel census sampling of the king salmon fishery revealed that during the period from September 1 through December 31, 1947, approximately 3,300 salmon weighing 62,400 pounds were taken in 83,200 hours of angling by 23,400 fishing efforts between Middle Creek and Chico Creek. During the following fishing season, May 1, 1948 - February 28, 1949, approximately 8,000 salmon weighing 136,200 pounds were taken in 171,300 hours of angling by 43,800 fishing efforts from the same area.

The sports fishery for king salmon ranked first in importance in the number of fishing efforts and hours expended during the 1948-49 season when censuses were made of all fisheries concurrently. The salmon catch was second in number but was first in estimated poundage.

Table 3

Graphic Representation of Completed Fishing Efforts



The monthly catch pattern for king salmon followed closely the movements and activities of the salmon in the Upper Sacramento River area during the 1948-49 season. As shown in Table 4, the catch increased from May to June as the spring run gained force and decreased somewhat in July as the migration subsided and most salmon were resting in deeper holes awaiting spawning maturity. The catch increased again in August as the spring-run salmon started their pre-spawning migrations, and continued to increase in September as the fall migrants started to enter the fishery. A peak catch in October coincided with the peak of the fall migration. The catch dropped sharply in November as migrant salmon became less common, most of the fishing being done on spawning riffles. A small number of salmon was taken in December when nearly all fishing was on salmon spawning areas near Redding. A sizeable winter run appeared in 1949 and the salmon catch presumably increased in January and February in proportion with the number of migrating salmon. These winter-run king salmon also enter the catch in May, June and early July of the following fishing season, when they are caught on their spawning areas.

For the period from September 1 through December the king salmon sports catch increased from some 3,300 in 1947 to 4,900 in 1948. Estimates of the spawning populations of salmon for these years were constant or slightly smaller in 1948. An increase in the bag limit from two salmon in 1947 to three salmon in 1948 may have contributed somewhat to the increased catch in 1948, although the number of limit catches was not great in either year. The increased catch can more likely be attributed to the greater use of boats in 1948; three boat liveries were in operation in 1947 and eight in 1948. With the increased use of boats, the area from which salmon were taken became less restricted and a larger catch resulted.

The number of fishing efforts for king salmon followed closely the catch pattern, and only one exception was found during the period of this study. This occurred in September, 1948, when the number of fishing efforts fell to some 6,100 from 6,550 in August and the catch increased to about 1,050 from 980 in August. This reversal of the usual trend resulted from a slight increase in the length of the fishing effort and catch per hour which more than offset the reduction in fishing efforts. In general, however, it can be said that the number of fishing efforts for salmon varied directly with the number and availability of the salmon.

The number of fishing efforts for salmon decreased from some 23,400 in 1947 to 21,800 in 1948 for the period of September through December, even though the catch increased in the latter year. The decrease in the number of fishing efforts can be attributed to: (1) the concentrated fishing and greater use of boats in the lower river area with the resultant lessened availability of salmon in the upper river; (2) the closure of three county bridges to fishing; and (3) the change in the spawning pattern of salmon during the latter season when the most intense spawning was near the middle, rather than the upper end, of the spawning area.

The length of the completed fishing effort appeared to have no set pattern. It seemed to be influenced most by the weather and the number and availability of the salmon. The fishing effort tended to be longer when the weather was mild and salmon were abundant. The increase in the length of the fishing effort from the average of 3.4 hours during the fall of 1947 to 4.13 hours for the comparable period in 1948, (Table 4) can be attributed to the extensive increase in the use of boats during the latter season, as boat fishermen generally fished longer.

In all but two of the fourteen months of the salmon creel census the catch per hour tended to vary inversely with the total catch. The two exceptions were September and October of 1948, during the main fall salmon migration. At this time boat fishing reached a density never before approached in the area below Red Bluff, and boat fishermen had spread to cover almost every mile of the river.

The catch per hour increased, as did the length of the fishing effort, from 0.04 (25 hours per fish) in the fall of 1947 to 0.05 (20 hours per fish) during the same period of 1948. This also resulted from an increase in boat fishing which, due to its ability to cover more area, produced a greater catch per hour than bank or bridge fishing. Bridge fishing, the least productive method of fishing, was almost absent after most bridges were closed to fishing early in October of 1948.

Rainbow-Steelhead Trout Fishery

Creel census sampling of the rainbow-steelhead trout fishery revealed that approximately 3,800 rainbow and steelhead trout were taken in 43,900 hours of angling by 10,900 fishing efforts between Middle Creek and Chico Creek from December 1, 1947 - February 29, 1948. During the following fishing season, May 1, 1948 - February 28, 1949, there were approximately 10,200 trout taken in 141,500 hours of angling by 43,200 fishing efforts.

The rainbow-steelhead trout sports fishery ran a close second to salmon in the number of fishing efforts and hours of effort, but was first in the number of fish taken during the 1948-49 season. Most anglers who fish for both trout and salmon regarded trout as a second choice because, although more trout were taken, salmon made up in weight what they lacked in number.

The trout catch throughout the season depended somewhat upon their availability. This was revealed by the fact that the catch per hour increased or decreased with the catch in all but three of the thirteen months of trout census (Table 5). These months were July, October and

Table 4

King Salmon Sports Fishery
Upper Sacramento River

1947*

Month	Fishermen Sampled	Hours per Complete Effort**	Catch per Hour **	Computed Total Fishing Efforts	Total Hours Fished	Catch	Weight of Catch***
September	290	2.90	0.041	6,019	17,455	715	13,728
October	350	3.84	0.038	11,444	43,943	1,670	32,064
November	199	3.69	0.039	5,762	21,261	829	15,917
December	9	2.88	0.067	195	561	38	730
Totals	848	3.40	0.040	23,420	83,220	3,252	62,439

1948-49 Season

Month	Fishermen Sampled	Hours per Complete Effort**	Catch per Hour**	Computed Total Fishing Efforts	Total Hours Fished	Catch	Weight of Catch***
May	301	3.51	0.038	4,093	14,154	549	9,398
June	260	4.35	0.032	5,937	24,076	782	13,372
July	236	3.83	0.046	3,923	13,347	608	10,397
August	402	4.19	0.036	6,552	27,447	983	16,809
September	563	4.47	0.040	6,096	26,163	1,051	17,972
October	739	3.94	0.053	12,102	49,054	3,009	50,454
November	304	3.89	0.063	3,411	12,985	801	13,697
December	15	2.45	0.059	177	434	26	445
January	44			380	931	55	941
February	85			1,087	2,663	156	2,668
Totals	2,949	3.97	0.046	43,758	171,254	8,020	136,153
Totals Sept.-Dec. 1948	1,621	4.13	0.050	21,786	88,636	4,887	83,568

* Fishery in January and February too light for analysis
** Not used for computations, which are made by sections.
*** Average weight of 464 salmon = 19.2 lbs. in 1947 and 2101 salmon = 17.1 lbs., in 1948-49.

Table 5

Rainbow-Steelhead Trout Sports Fishery
Upper Sacramento River

1947-48 Season

Month	Fishermen Sampled	Hours per Complete Effort*	Catch per Hour*	Computed Total Fishing Efforts	Total Hours Fished	Catch
December	73	3.78	0.051	3,110	11,757	648
January	59	3.05	0.092	3,145	9,591	876
February	126	4.83	0.100	4,658	22,496	2,284
Totals	258	4.23	0.086	10,913	43,844	3,808

1948-49 Season

Month	Fishermen Sampled	Hours per Complete Effort*	Catch per Hour*	Computed Total Fishing Efforts	Total Hours Fished	Catch
May	308	3.26	0.107	5,113	16,644	1,793
June	143	2.91	0.056	8,990	25,914	1,194
July	141	3.22	0.064	2,408	8,040	512
August	113	2.49	0.140	4,249	10,875	1,527
September	144	3.21	0.074	2,237	6,880	501
October	324	3.64	0.060	8,230	29,976	1,741
November	343	4.24	0.057	5,619	23,776	1,362
December	84	3.57	0.087	1,484	4,039	372
January	123	3.48	0.113	2,213	6,070	644
February	237	3.50	0.061	2,656	9,305	565
Totals	1,960	3.39	0.075	43,199	141,519	10,211
Totals Dec. 1948-Feb. 1949	444	3.51	0.079	6,353	19,414	1,581

* Not used for computations which are made by sections

December of 1948. July was the hottest month of 1948 and this factor, coupled with an abundance of salmon in the upper river area where most trout were taken, reduced the amount of fishing effort and in turn the catch. Trout fishermen were drawn to salmon spawning areas during October, 1948, where trout are believed to be more vulnerable as they feed on salmon eggs lost in the spawning process. Thus, the heavy fishing pressure and catches in October are not reflected in the lower catch per hour. Unusually severe weather in December recuded the number of trout fishermen and catch regardless of the increased availability.

During the comparable periods, December through February, in 1947-48 and 1948-49, the catch fell from some 3,800 to 1,600 trout (Table 2). A slight reduction in the catch per hour in the latter year influenced the catch. A marked reduction in the length of the fishing effort and number of fishing efforts, due to the unusually cold winter of 1948-49, probably contributed most to the reduced catch.

The number of rainbow-steelhead fishing efforts varied directly with the catch in all except one of the thirteen months of analysis. This exception occurred in February when fishing pressure increased along with somewhat improved weather conditions, but the catch per hour dropped enough to prevent an increased catch for the month. The number of fishing efforts seemed to be most dependent on conditions other than the abundance and availability of the trout. Four peaks in fishing effort occurred during the 1948-49 fishing season. The greatest peak occurred in June when most anglers seemed to take their first lengthy fishing vacations in 1948; a minor peak came in August, which was the heaviest tourist month (trout fishing parties travel farther in August than any other month - Table 8); a second major peak came in October during the period of heaviest salmon fishing and an increase in salmon spawning activity, both of which attract many trout fishermen; the last and least peak in fishing pressure came in February and was influenced by the season's close at the end of the month and more favorable fishing weather during the month. If fishing intensity was influenced by the availability of trout as shown by the catch per hour, major peaks would have occurred in June, August and January.

The number of trout fishing efforts during December through January decreased from some 10,900 in 1947-48 to 6,400 in 1948-49. The reduction was a direct result of the colder weather during the latter season.

The length of the fishing effort for trout seemed to have little relationship to the availability of fish or the catch. This factor seemed to depend mostly on weather and fishing conditions. During the three months of comparison of the 1947-48 and 1948-49 fishing seasons, the length of the fishing effort fell from 4.23 hours to 3.10 hours. This can be attributed to colder weather during the latter period.

The catch per hour for trout increased or decreased with the catch in most instances as discussed previously. This appears to be a coincidence as it has been shown that there was a stronger relationship between the number of fishing efforts and the catch. This characteristic seemed to offset any adverse relationship between the catch per hour and the catch. The catch per hour for trout did not appear to follow a pattern of the abundance of trout. The greatest abundance of trout is believed to occur from October through February when the heaviest steelhead spawning migrations take place. The catch per hour, however, did not show significant or sustained increase during this period as compared to other months of the fishing season when mostly resident rainbows or river resident steelhead were taken.

The catch per hour for trout fell from 0.086 (12 hours per fish) during the period from December through February 1947-48 to 0.076 (13 hours per fish) fish per hour in the same months of 1948-49. The reason for the reduction in catch per hour is not known but it is not believed to be a definite indication of a reduced population in the latter period.

Striped Bass Fishery

During the months May through September, 1948, there were approximately 600 striped bass taken in 14,300 hours of angling by 5,100 fishing efforts between Red Bluff and Chico Creek. Striped bass fishing above Red Bluff in 1948 was virtually absent.

The striped bass fishery ranked third in importance in the number of fishing efforts and hours fished and fourth in number of fish taken.

The monthly catch of striped bass seemed to vary directly with their abundance in the Upper Sacramento River area. The striped bass migrate into the upper river starting early in May, reaching an apparent peak in July and subsiding through September as they move downstream. The monthly catch follows this same pattern (Table 6).

The number of fishing efforts, hours per fishing effort and catch per hour vary directly with the catch. Thus it appears that all factors relating to the striped bass fishery are dependent upon the abundance of the fish.

Although a few people fish for striped bass from October through April, no catches have been recorded for those months.

Table 6

Striped Bass Sports Fishery
Upper Sacramento River

1948

Month	Fishermen Sampled	Hours per Complete Effort	Catch per Hour	Computed Total Fishing Efforts	Total Hours Fished	Catch
May	4	-	-	212	519*	11*
June	50	2.45	0.022	840	2,058	45
July	156	3.53	0.060	2,104	7,427	449
August	86	2.62	0.022	1,204	3,367	74
September	28	1.41		630	888	19
Totals	899	2.94	0.042	5,071	14,259	598

* Computed from factors for June

Catfish Fishery

During the most important months of the river catfish fishery, May through September 1948, approximately 1,300 catfish were taken in 4,700 hours of angling by 2,500 fishing efforts between Red Bluff and Chico Creek. River fishing for catfish above Red Bluff was virtually absent.

Catfish fishing ranked fourth in importance in the number of fishing efforts and the number of hours fished. In the number of fish taken, catfish ranked third.

The catfish catch is taken almost entirely during the months of May through September. During these months the warmest river water temperatures occur in the area where catfish are taken. The catch must be controlled by thermal migrations from sloughs into the river during the warmer months. The changes of catch per hour follow this supposed abundance pattern and vary directly with the catch (Table 7). The catch per hour also increased and decreased with the catch.

Table 7

Catfish Sports Fishery
Upper Sacramento River

1948

Month	Fishermen Sampled	Hours per Complete Effort	Catch per Hour	Computed Total Fishing Efforts	Total Hours Fished	Catch
May	38	1.99	0.071	687	1,367	98
June	21		0.523	510	1,015	531
July	28	2.57	0.314	446	1,146	360
August	18	1.38	0.262	584	806	211
September	15			274	378	99
Totals	122	2.30	0.305	2,501	4,712	1,229

The number of fishing efforts for catfish did not vary with the catch in 1948. The greatest fishing effort took place in May when the weather was mild and fishing conditions were favorable. A secondary peak in fishing effort occurred in August and was probably caused to some extent by the increased number of tourists, although most catfish fishing is done by local people.

Shad Fishery

A very few shad fishermen were contacted in the creel census along the river below Red Bluff during May, June and July, 1948. Most catches recorded were taken incidental to salmon fishing. Most shad fishing with bump-nets (dip nets) takes place all hours of the night and was, therefore, not considered in regular census sampling or analysis.

Distance Traveled by Sports Fishermen

During the 1948-49 fishing season an accurate record was kept of the location from which fishermen traveled to fish. In many instances this was not their residence, but the location of their last stop on extensive fishing trips or the residence of friends or relatives whom they were visiting if fishing was incidental to the visit. Campers were recorded as local after the first day.

King salmon fishermen traveled farthest to fish on the Upper Sacramento River, with an average for the season of 55 miles per party; trout fishing parties traveled an average of 39 miles; striped bass fishing parties averaged 25 miles; and catfish fishing parties averaged 11 miles (Table 8). The total mileage traveled by fishermen amounted to approximately 1,363,000 for salmon, 1,029,000 for trout, 221,000 for striped bass and 32,000 for catfish.

Early season enthusiasm in 1948 caused salmon fishermen to travel an average of 66 miles in May. The mileage fell to 43 in June. The distance traveled during July and August remained constant at 56 miles which was not greatly influenced by tourist anglers who seldom carry the heavy gear required for salmon fishing. The distance traveled increased to 67 miles in September as the fall salmon run entered the fishery. A decrease to 48 miles was noted in October when fishing was heaviest and many people camped along the river for considerable periods. The mileage traveled increased to 61 miles in November as camping became less common and reached a peak of 83 miles in December when a few people traveled long distances to catch salmon on spawning riffles where they were most accessible. Salmon fishing was mostly local in January and February, 1949, when the mileage dropped to 8 and 21 miles respectively. The increased distance of travel in February was influenced by more favorable weather and increased catches.

Table 8

Distance Traveled by Fishermen
on the
Upper Sacramento River

1948-49 Season

Month	King Salmon		Rainbow-Steelhead Trout		Striped Bass*		Catfish*	
	Miles per Party	Total Miles	Miles per Party	Total Miles	Miles per Party	Total Miles	Miles per Party	Total Miles
May	66	159,586	29	92,085	10	3,804	8	6,206
June	43	158,696	17	113,634	17	23,091	9	5,268
July	56	119,808	68	103,905	31	136,657	16	13,202
August	56	202,195	75	180,158	23	43,670	11	4,433
September	67	230,916	56	83,395	22	13,515	11	3,058
October	48	334,136	40	199,248				
November	61	126,548	55	191,552				
December	83	12,487	17	16,947				
January	8	2,379	12	16,642				
February	21	15,935	19	31,766				
Totals	55	1,362,686	39	1,029,342	25	220,737	11	32,167

* Too few striped bass and catfish fishermen for analysis after September.

Rainbow-steelhead trout fishing parties traveled an average of 29 miles during May, 1948. The distance traveled dropped to 17 miles in June as the opening day enthusiasm subsided. An increase to 68 miles in July and 75 miles in August corresponded with the intensity of tourist traffic. A drop to 56 miles in September followed a slackening in tourist travel. During October, the heaviest trout fishing month of the season, the mileage again dropped to 40 miles as camping fishermen increased in number. Camping dropped off in November, another month of heavy trout fishing, and the average distance traveled increased to 55 miles. Trout fishing was mostly local during December, January and February when the travel dropped to 17 miles, 12 miles and 19 miles respectively.

The distance traveled by striped bass fishermen varied directly with the catch. Travel increased from a low of 10 miles per party in May, 1948, to 31 miles during July when greatest catches were made. The mileage fell to 22 miles in September as catches fell off sharply. Striped bass fishing was mostly local. Most traveling or vacation fishermen turned to striped bass as a second choice.

The distance traveled by catfish fishermen followed closely the pattern for striped bass. The fisheries are very closely related as it is possible to fish for both species with the same bait in some locations. Travel by catfish fishermen varied from 10 miles in May, 1948, to a peak of 16 miles in July and subsided to 11 miles in September. Catfish fishermen were mostly of local origin.

EVALUATION OF THE SPORTS FISHERY

The increasing value of the sports fishery along the Upper Sacramento River is clearly demonstrated by the rapid growth of business benefiting from the fishery. In 1945 there were no commercial boat landings in the upper river area. The first organized sportsmen's landing and rental was established in 1946 and three were operating during 1947. At the close of the 1948 season, eight boat landings were in operation, and three additional landings went into operation in the early part of the 1949 season. The greatest known growth in the number of establishments carrying complete lines of fishing tackle occurred in the Orland-Chico area where the number increased from some 3 to 21 during the period from 1945 to 1949.

Of the eight boat landings in operation at the end of 1948, five were in full operation most of the year. At the close of the year the eight landings were valued at $104,000 and had a gross income for the year of $40,200. The gross income of the five landings in full operation was $34,000, averaging $6,820 per landing. The eight landings offered 98 boats and 53 motors for rent to fishermen. All eight offered private docking facilities, five had tackle shops, six served refreshments, three served lunch, five had trailer space and one had cabins for rent. Twelve full-time and ten part-time employees operated the eight boat landings, putting in 176 man months of labor during the 1948 season.

In the area bordering the Upper Sacramento River, bounded by Redding to the north and Chico and Orland to the south, 38 establishments other than boat landings carried complete stocks of fishing tackle and equipment at the close of 1948. Twenty-three of these establishments sold outboard motors and 12 sold boats to fishermen. The gross sales of tackle, equipment, boats and motors in this area during 1948 was $435,000. Forty-five employees devoted all or part of their time to sales of fishing equipment expending an estimated 201 man months of labor during 1948. Fishing equipment sold in this area but not used on the river was probably more than compensated for by tackle sold outside the area and used for river fishing. Nearly half of the fishermen on the river originate from outside the area and purchase their major items of fishing equipment in their home towns. Thus the above value can be attributed to the river fishery.

In summary, there were a total of 46 establishments receiving major benefits from the sports fishery during 1948. There were 67 full and part-time employees who derived all or part of their income from work in boat rentals or tackle shops. The gross income for all establishments during 1948 was $475,200. At 4 percent this represents an $11,880,000 investment in the sports fishery of the Upper Sacramento River.

SUMMARY

1. Changes in the environmental conditions of the Upper Sacramento River following the construction of Shasta Dam have resulted in marked changes in game fish populations. An investigation was initiated in August, 1947, to learn how these changes have influenced the sports fishery.

2. Before the construction of Shasta Dam, the Upper Sacramento River was a warm-water river. The most common game fish found in order of their probable importance were the striped bass, catfish, largemouth bass, bluegill, Sacramento perch, shad, Sacramento sucker, carp and Sacramento squawfish. King salmon and steelhead trout produced seasonal fisheries in fall and winter months.

3. Increased summer flows released from sub-thermocline depths of Shasta Reservoir changed the Upper Sacramento to a cold-water river. Adult and young salmon are year-round residents in the upper river, as are the rainbow and steelhead trout. These species now produce continuous sports fisheries. Game fish of lesser importance since operation of Shasta Dam began, in order of their importance, are the striped bass, catfish, shad, Sacramento squawfish, Sacramento sucker, carp and smallmouth and largemouth bass.

4. A creel census of the Upper Sacramento River sports fishery was started on the first of September, 1947. Early creel census methods were exploratory, leading to a sampling method of making a census of the 108 miles of river between Middle Creek, near Redding, and Chico Creek. An airplane was used for the census of fishermen in isolated portions of the river. Analysis of data from creel census samples involved determination of the portion of the fishery sampled and increasing it accordingly to represent the whole.

5. During the period from September 1 through December 31, 1948, approximately 3,300 king salmon weighing 62,400 pounds were taken in 83,200 hours of angling by 23,400 fishing efforts. In the following season, May 1, 1948 - February 28, 1949, approximately 8,000 salmon weighing 136,200 pounds were taken in 171,300 hours of angling by 43,800 fishing efforts. The monthly catch pattern followed closely the movements and abundance of king salmon in the Upper Sacramento River. The catch and number of fishing efforts for salmon increased during the fall of 1948 over the same period of 1947 due to increased interest in the fishery. The length of the completed fishing effort for salmon seemed to be influenced by the weather and the availability of salmon but had no set pattern. The catch per hour showed a strong inverse relationship with the catch and fishing intensity.

6. During the period from December 1, 1948, through February 29, 1949, approximately 3,800 rainbow and steelhead trout were taken in 43,900 hours of fishing by 10,900 fishing efforts. During the following season, May 1, 1948 - February 28, 1949, approximately 10,200 trout were taken in 141,500 hours of fishing by 43,200 fishing efforts. The trout catch seemed to be influenced somewhat by the availability of fish as shown by the catch per hour but had a much stronger direct relationship with the number of fishing efforts. The catch per hour did not vary directly with the abundance pattern of the rainbow and steelhead trout. There were fewer trout caught and fewer fishing efforts during the winter of 1948-49 than for comparable months of 1947-48 due to unusually cold weather in December, 1948, and January, 1949.

7. During the months from May through September, 1948, approximately 600 striped bass were taken in 14,300 hours of angling by 5,100 fishing efforts. The catch, number of fishing efforts and catch per hour all varied directly with the apparent abundance pattern of striped bass as they moved into and out of the Upper Sacramento River area.

8. During the most important months of catfish fishing, May through September, 1948, approximately 1,300 catfish were taken in 4,700 hours of angling by 2,500 fishing efforts. The catfish apparently made thermal migrations into the river from slough areas during these months and the catch, fishing effort and catch per hour followed closely the supposed migration pattern.

9. The shad, squawfish, sucker, carp and black bass fisheries were too small to be analyzed by the creel census sampling methods. Intentional fishing for these species was seldom found, most catches being incidental to the more important fisheries.

10. During the season May, 1948, through February, 1949, king salmon fishing parties traveled an average of 55 miles, rainbow-steelhead trout parties 39 miles, striped bass parties 25 miles and catfish parties 11 miles. The distance traveled by salmon fishermen varied directly with the abundance of salmon. The distance traveled by trout fishermen seemed to be influenced primarily by the vacation season and secondarily by the abundance of trout. The distance traveled by striped bass and catfish fishermen varied directly with the abundance and availability of the fish.

11. The number of boat landings on the Upper Sacramento River increased from one in 1946 to eleven in the early part of 1949. The eight in operation at the close of 1948 were valued at $104,000 and grossed $40,200 during the year. In the area limited by Redding, Chico and Orland there were 38 establishments, other than boat landings, that carried complete stocks of fishing equipment; they grossed $435,000 during 1948. Thus a total of $475,200 was grossed from the Upper Sacramento River sports fishery in 1948, which, at 4 percent, represents an investment of $11,880,000.

LITERATURE CITED

1949. Moffett, J. W., The First Four Years of King Salmon Maintenance below Shasta Dam, Sacramento River, California. California Fish and Game Bulletin No. 35, pp. 77-102.

1935. Eschmeyer, R. W., Analysis of the Game-Fish Catch in a Michigan Lake. Trans. American Fisheries Society, Vol. 65, pp. 207-223.

APPENDIX TABLE IA

King Salmon Creel Census Summary
1948-49 Season

	Month	Fishermen Contacted: Parties c_1	Fishermen Contacted: Fishermen d_1	Hours Fished	Catch	Efforts Complete	Hours of Complete Effort	Fishermen Seen: Parties c_2	Fishermen Seen: Fishermen d_2
Section A	May	54	78	103.00	9	47*	133.50	**	
	June	69	111	285.75	12	67*	224.25	**	
	July	68	130	321.75	16	216*	920.25	64	130
	August	54	100	266.25	11	49	188.00	37	78
	September	131	221	454.50	19	65	218.00	72	145
	October	171	279	752.00	18	99	355.50	101	177
	November	102	167	477.50	32	81	320.25	112	176
	December	12	14	11.00	1	0	0	5	6
	January	3	3	3.75	0	3	3.75	1	1
	February	29	46	91.50	3	22	63.00	22	41
Subtotals		693	1,149	2,767.00	121	649	2,426.50	414	754
Section B	May	125	223	403.25	10	176*	649.50	**	
	June	92	149	360.50	9	133*	646.25	**	
	July	67	106	156.50	6	72*	184.00	38	71
	August	169	302	734.50	25	129	557.00	150	270
	September	209	342	1,014.25	40	140	699.25	127	246
	October	289	460	1,287.50	90	141	590.00	561	1,024
	November	86	137	280.75	16	26	96.00	91	162
	December	1	1	.25	0	0	0	0	0
	January	33	41	51.75	5	6	16.75	8	13
	February	35	39	46.25	3	13	24.25	11	16
Subtotals		1,106	1,800	4,335.50	204	836	3,463.00	986	1,802
TOTALS		1,799	2,949	7,102.50	325	1,485	5,889.50	1,400	2,556

* Census samples and complete census data combined
** No record of parties in May and June

APPENDIX TABLE I B

King Salmon Fishermen by Creel Census Sample
1948-49 Season

	Month	Sundays*					Week Days					Saturdays				
		Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled
		a	b	x1	x2	T.F.S.	a	b	x1	x2	T.F.S.	a	b	x1	x2	T.F.S.
Section A	May	62	28	6	6	102.44	13	2	4	20	79.45	47	11	5	5	62.89
	June	100	27	4	4	143.43	42	3	3	22	343.42	77	30	4	4	125.26
	July	117	45	5	5	205.64	36	9	5	21	225.67	111	15	5	5	140.55
	Aug.	74	27	4	5	158.51	17	4	3	22	182.01	87	17	4	4	120.25
	Sept.	237	19	5	5	271.26	83	8	6	21	340.97	94	9	4	4	110.23
	Oct.	260	31	5	5	311.97	66	1	4	21	355.32	207	14	5	5	230.47
	Nov.	261	34	5	5	315.50	30	1	4	21	165.90	81	12	4	4	100.23
	Dec.	11	0	4	4	11.00	3	0	4	23	17.25	10	0	4	4	10.00
	Jan.	1	0	4	5	1.00	0	0	4	21	0	3	0	4	5	3.75
	Feb.	35	7	4	4	46.94	16	1	4	20	88.55	36	1	4	4	37.71
Section B	May	199	62	5	6	371.53	50	21	4	20	437.30	85	10	5	5	102.84
	June	147	30	4	4	195.59	83	22	4	22	652.47	79	18	4	4	108.15
	July	84	12	5	5	104.23	28	4	4	21	182.39	65	4	5	5	71.74
	Aug.	228	69	5	5	351.72	177	15	5	22	897.16	167	34	4	4	227.97
	Sept.	311	46	5	5	391.50	114	8	4	21	672.00	166	32	4	4	222.00
	Oct.	648	224	5	5	1039.08	252	47	4	21	1753.82	635	108	5	5	823.56
	Nov.	132	47	5	5	211.40	52	11	5	21	296.44	115	20	4	4	148.79
	Dec.	0	0	4	4	0	0	0	4	23	0	1	0	4	4	1.00
	Jan.	35	2	4	5	47.04	3	1	4	21	22.68	21	2	4	5	29.54
	Feb.	15	1	4	4	16.20	18	3	5	20	86.36	21	2	4	4	23.39
	Totals	2957	711	46	48	4295.98	1083	161	43	212	6799.16	2108	339	43	44	2700.32

* National holidays in midsummer included as Sundays

Formula: $$T.F.S. = \frac{\left(a + \left[\frac{b\,(d_1 + d_2)}{c_1 + c_2}\right]\right) \times 2}{x_1}$$

Appendix Table IC

King Salmon Fishery
Analysis of Complete Efforts and Complete Census
1948-49 Season

	Month	Hours of Sampling	Hourly Intervals	Fishermen Present at Hourly Intervals	Number of Fishermen Involved	Percent of Fishermen Present per hour
			i	f	n	% F.P.
Section A	May	0630 - 1900	13	147*	47	24.06
	June	0630 - 1930	13	214*	67	24.57
	July	0600 - 2000	15	759*	158	32.03
	Aug.	0630 - 1930	13	179	49	28.10
	Sept.	0630 - 1845	12	217	65	27.82
	Oct.	0645 - 1730	11	390	99	35.81
	Nov.	0700 - 1700	11	368	81	41.30
	Dec.	0730 - 1700	10	0	0	27.50**
	Jan.	0730 - 1700	10	5	3	27.50**
	Feb.	0730 - 1700	10	71	22	27.50**
Section B	May	0630 - 1900	13	440	99	34.19
	June	0630 - 1930	13	363	80	34.90
	July	0600 - 2000	15	124	42	19.68
	Aug.	0630 - 1930	13	567	129	33.81
	Sept.	0630 - 1845	12	711	140	42.32
	Oct.	0645 - 1730	11	643	141	41.46
	Nov.	0700 - 1700	11	109	26	38.11
	Dec.	0730 - 1700	10	0	0	27.50**
	Jan.	0730 - 1700	10	18	6	27.50**
	Feb.	0730 - 1700	10	27	13	27.50**
	Totals			5,352	1,267	

* Complete efforts and complete census data combined

** December, January and February data combined

Formula: $\% \text{ F.P.} = \frac{f \times 100}{i \times n}$

APPENDIX TABLE ID

Airplane Census of King Salmon Fishermen
1948-49 Season

Month	Section A			Section B		
	Fishermen at Census Stations		Fishermen Between Census Stations	Fishermen at Census Stations		Fishermen Between Census Stations
	Number	Percent		Number	Percent	
May	31	91.18	3	43	89.58	5
June	37	78.72	10	80	98.77	1
August				66*	91.67	6
September	48	100.00	0	79	86.81	12
October	55	98.21	1	243	91.35	23
December	4	80.00	1	0	0	0
January	0		0	1	100.00	0
February	9	100.00	0	5	100.00	0
Totals	184	92.46	15	517	91.67	47

* Boat Census

APPENDIX TABLE I E

King Salmon Analysis Sheet

1948-49 Season

	Month	Fishermen by Sample	Percent by Sample	Fishermen at Census Stations	Percent at Census Stations	Fishermen in Study Area	Hours per Complete Effort	Hours of Fishing Effort	Catch per Hour	Catch
Section A	May	245	24.06*	1,018	91.18	1,116	2.84*	3,169	.0874	277
	June	612	24.57*	2,491	78.72	3,164	3.35*	10,599	.0420	445
	July	572	32.03	1,786	91.87***	1,944	4.26*	8,281	.0500	414
	August	461	28.10	1,641	91.87***	1,786	3.84	6,858	.0413	283
	September	722	27.82	2,595	100.00	2,595	3.35	8,693	.0418	363
	October	898	35.81	2,508	98.21	2,554	3.58	9,143	.0239	219
	November	582	41.30	1,409	91.87***	1,534	3.95	6,059	.0670	406
	December	38	27.50**	138	80.00	173	2.45**	424	.0587**	25
	January	5	27.50**	18	91.87	20	2.45**	49	.0587**	3
	February	173	27.50**	629	100.00	629	2.45**	1,541	.0587**	90
Section B	May	912	34.19	2,667	89.58	2,977	3.69	10,985	.0248	272
	June	956	34.90	2,739	98.77	2,773	4.86	13,477	.0250	337
	July	358	19.68	1,819	91.87***	1,979	2.56	5,066	.0383	194
	August	1,477	33.81	4,369	91.67	4,766	4.32	20,589	.0340	700
	September	1,286	42.32	3,039	86.81	3,501	4.99	17,470	.0394	688
	October	3,616	41.46	8,722	91.35	9,548	4.18	39,911	.0699	2,790
	November	657	38.11	1,724	91.87***	1,877	3.69	6,926	.0570	395
	December	1	27.50**	4	91.87***	4	2.45**	10	.0587**	1
	January	99	27.50**	360	100.00	360	2.45**	882	.0587**	52
	February	126	27.50**	458	100.00	458	2.45**	1,122	.0587**	66
	Totals	13,796		40,133		43,758		171,254		8,020

* Complete efforts and complete census data combined
** December, January and February data of both sections combined
*** Percent for season

APPENDIX TABLE II A

Rainbow-Steelhead Trout Creel Census Summary
1948-49 Season

	Month	Fishermen Contacted		Hours Fished	Catch	Efforts Complete	Hours of Complete Effort	Fishermen Seen	
		Parties	Fishermen					Parties	Fishermen
		c_1	d_1					c_2	d_2
Section A	May	164	278	549.50	64	104*	359.25	**	
	June	98	136	239.75	11	54*	156.50	**	
	July	77	119	242.50	15	65*	229.50	24	38
	August	54	95	164.50	24	76*	184.50	20	38
	September	60	88	160.25	11	26	72.00	33	46
	October	72	126	267.00	10	38	142.75	100	175
	November	70	117	350.00	23	54	218.75	73	113
	December	14	21	24.25	2	3	7.50	8	15
	January	35	54	70.50	7	19	39.00	17	24
	February	82	137	305.25	22	39	139.25	29	49
	Subtotals	726	1,171	2,373.50	189	478	1,549.00	304	498
Section B	May	22	30	46.25	0	18*	38.00	**	
	June	6	7	11.00	3	9*	26.75	**	
	July	13	22	38.50	3	23*	54.25	1	1
	August	10	18	29.00	3	9*	26.75	3	4
	September	36	56	151.00	12	21	79.00	29	45
	October	125	198	450.00	33	51	181.50	175	281
	November	148	226	506.50	26	74	323.50	163	275
	December	41	63	101.75	9	21	78.25	18	23
	January	43	69	159.75	19	25	114.75	21	31
	February	64	100	189.75	8	24	81.50	31	48
	Subtotals	508	789	1,683.50	116	275	1,004.25	441	708
	TOTALS	1,234	1,960	4,057.00	305	753	2,553.25	745	1,206

* Census samples and complete census data combined
** No record of parties in May and June

APPENDIX TABLE II B

Rainbow-Steelhead Trout Fishermen by Creel Census Sample

1948-49 Season

	Month	Sundays*					Week Days					Saturdays				
		Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled
		a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.
Section A	May	159	37	6	6	221.72	43	11	4	20	308.25	95	31	5	5	147.55
	June	76	29	4	4	116.24	50	3	3	22	397.17	57	11	4	4	72.27
	July	63	19	5	5	92.53	24	3	5	21	120.37	70	7	5	5	80.88
	Aug.	55	18	4	5	109.19	38	2	3	22	304.99	40	0	4	4	40.00
	Sept.	85	17	5	5	109.49	38	3	6	21	148.12	29	0	4	4	29.00
	Oct.	151	56	5	5	249.00	51	5	4	21	313.69	132	36	5	5	195.00
	Nov.	116	71	5	5	230.20	31	7	4	21	221.87	95	9	4	4	109.48
	Dec.	24	1	4	4	25.64	4	5	4	23	70.04	24	11	4	4	42.00
	Jan.	35	3	4	5	49.38	23	3	4	21	144.38	33	4	4	5	48.75
	Feb.	87	19	4	4	118.84	48	3	4	20	265.15	51	11	4	4	69.43
Section B	May	28	4	5	6	40.14	6	5	4	20	64.10	18	6	5	5	26.18
	June	11	0	4	4	11.00	6	1	4	22	39.44	2	1	4	4	3.17
	July	4	0	5	5	4.00	8	0	4	21	42.00	11	0	5	5	11.00
	Aug.	10	1	5	5	11.69	10	0	5	22	44.00	2	5	4	4	10.46
	Sept.	42	4	5	5	48.22	25	0	4	21	131.25	40	1	4	4	41.55
	Oct.	184	67	5	5	290.98	124	6	4	21	701.30	184	29	5	5	230.30
	Nov.	232	69	5	5	343.15	136	12	5	21	652.39	150	23	4	4	153.71
	Dec.	35	3	4	4	39.37	11	0	4	23	63.25	46	6	4	4	54.75
	Jan.	93	7	4	5	129.93	12	6	4	21	112.25	31	2	4	5	42.66
	Feb.	58	3	4	4	62.67	45	1	5	20	186.24	45	12	4	4	63.69
	Totals	1,548	428			2,303.38	733	76		212	4,330.25	1,155	205			1,471.83

* National holidays in midsummer included as Sundays

Formula shown in Appendix Table I B

Appendix Table IIC

Rainbow-Steelhead Trout Fishery
Analysis of Complete Efforts
1948-49 Season

	Month	Hours of Sampling	Hourly Intervals	Fishermen Present at Hourly Intervals	Number of Fishermen Involved	Percent of Fishermen Present per Hour
			i	f	n	%F.P.
Section A	May	0630 - 1900	13	387*	104	28.62
	June	0630 - 1930	13	163*	54	23.22
	July	0600 - 2000	15	252*	65	25.85
	Aug.	0630 - 1930	13	204*	76	20.65
	Sept.	0630 - 1845	12	74	26	23.72
	Oct.	0645 - 1730	11	150	38	35.89
	Nov.	0700 - 1700	11	243	54	40.91
	Dec.	0730 - 1700	10	10	3	25.45**
	Jan.	0730 - 1700	10	46	19	25.45**
	Feb.	0730 - 1700	10	148	39	37.95
Section B	May	0630 - 1900	13	42*	18	19.94***
	June	0630 - 1930	13	28*	9	19.94***
	July	0600 - 2000	15	62*	23	17.97
	Aug.	0630 - 1930	13	28*	9	23.93
	Sept.	0630 - 1845	12	87	21	34.52
	Oct.	0645 - 1730	11	188	51	33.51
	Nov.	0700 - 1700	11	364	74	44.72
	Dec.	0730 - 1700	10	90	21	47.39**
	Jan.	0730 - 1700	10	128	25	47.39**
	Feb.	0730 - 1700	10	82	24	34.17
	Totals			2,776	753	

* Complete efforts and complete census data combined
** December and January data combined
*** May and June data combined

Formula shown in Appendix Table IC

APPENDIX TABLE II D

Airplane Census of Rainbow-Steelhead Trout Fishermen
1948-49 Season

Month	Section A			Section B*		
	Fishermen at Census Stations		Fishermen Between Census Stations	Fishermen at Census Stations		Fishermen Between Census Stations
	Number	Percent		Number	Percent	
May	62	56.88	47	22	68.75	10
June	16	29.09	39	13	86.67	2
August				25**	78.12	7
September	18	78.26	5	38	92.68	3
October	28	62.22	17	46	75.41	15
December	16	51.61	15	48	76.19	15
January	13	61.90	8	35	89.74	4
February	31	73.81	11	15	88.24	2
Totals	184	56.44	142	242	80.67	58

* Includes striped bass and catfish fishermen
** Boat census

APPENDIX TABLE II E

Rainbow-Steelhead Trout Analysis Sheet
1948-49 Season

	Month	Fishermen by Sample	Percent by Sample	Fishermen at Census Stations	Percent at Census Stations	Fishermen in Study Area	Hours per Complete Effort	Hours of Fishing Effort	Catch per Hour	Catch
Section A	May	678	28.62*	2,369	56.88	4,165	3.45*	14,369	.1165	1,674
	June	586	23.22*	2,524	29.09	8,677	2.90*	25,163	.0459	1,155
	July	294	25.85*	1,137	56.44****	2,015	3.53*	7,113	.0619	440
	August	454	20.65*	2,199	56.44****	3,896	2.43*	9,467	.1459	1,381
	September	287	23.72	1,210	78.26	1,546	2.77	4,282	.0686	294
	October	757	35.89	2,109	62.22	3,390	3.76	12,746	.0375	478
	November	562	40.91	1,374	56.44****	2,434	4.05	9,858	.0657	648
	December	138	25.45**	542	51.61	1,050	2.11**	2,216	.0950**	211
	January	243	25.45**	955	61.90	1,543	2.11**	3,256	.0950**	309
	February	453	37.95	1,194	73.81	1,618	3.57	5,776	.0721	416
Section B	May	130	19.94***	652	68.75	948	2.40***	2,275	.0524***	119
	June	54	19.94***	271	86.67	313	2.40***	751	.0524***	39
	July	57	17.97*	317	80.67****	393	2.36*	927	.0779	72
	August	66	23.93*	276	78.12	353	2.97*	1,408	.1034	146
	September	221	34.52	640	92.68	691	3.76	2,598	.0795	207
	October	1,223	33.51	3,650	75.41	4,840	3.56	17,230	.0733	1,263
	November	1,149	44.72	2,569	80.67****	3,185	4.37	13,918	.0513	714
	December	157	47.39**	331	76.19	434	4.20**	1,823	.0885	161
	January	285	47.39**	601	89.74	670	4.20**	2,814	.1189	335
	February	313	34.17	916	88.24	1,038	3.40	3.529	.0422	149
	Totals	8,107		25,836		43,199		141,519		10,211

* Complete efforts and complete census data combined
** December and January data combined
*** May and June data combined
**** Percent for season in section

APPENDIX TABLE III A

Striped Bass Creel Census Summary
1948-49 Season

Month	Fishermen Contacted		Hours Fished	Catch	Efforts Complete	Hours Complete	Fishermen Seen	
	Parties	Fishermen					Parties	Fishermen
	c_1	d_1					d_2	d_2
May	3	4	4.75	0	0	0		
June	33	50	92.25	2	5	12.25	35	69
July	99	156	331.00	20	36	127.25	23	46
August	53	86	151.00	1	21	55.00	3	9
September	23	28	31.50	3	8	11.25	0	0
October	2	2	4.00	0	0	0	0	0
November	1	1	1.00	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0
Totals	214	327	615.50	26	70	205.75	61	124

APPENDIX TABLE III B

Striped Bass Fishermen by Creel Census Sample

1948-49 Season

Month	Sundays*					Week Days					Saturdays				
	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled
	a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.
May	15	0	5	6	18.00	1	0	4	20	5.00	5	0	5	5	5.00
June	22	0	4	4	22.00	17	0	4	22	93.50	20	3	4	4	24.55
July	119	16	5	5	145.87	38	1	4	21	208.32	68	11	5	5	86.47
Aug.	57	2	5	5	60.47	24	0	5	22	105.60	46	3	4	4	51.21
Sept.	24	0	5	5	24.00	7	0	4	21	36.75	11	1	4	4	12.42
Totals	237	18	24	25	270.34	87	1	21	106	449.17	150	18	22	22	179.65

* National holidays in midsummer included as Sundays

Formula shown in Appendix Table IB

Appendix Table III C

Striped Bass Fishery
Analysis of Complete Efforts and Complete Census

1948-49 Season

Month	Hours of Sampling	Hourly Intervals	Fishermen Present at Hourly Intervals	Number of Fishermen Involved	Percent of Fishermen Present per Hour
		i	f	n	% F.P.
May	0630 - 1900	13			
June	0630 - 1930	13	15	6	19.23
July	0600 - 2000	15	226	58	25.98
Aug.	0630 - 1930	13	59	21	21.61
Sept.	0630 - 1845	12	12	8	12.50
Totals			312	93	

Formula shown in Appendix Table IC

APPENDIX TABLE III D

Striped Bass Analysis Sheet
1948-49 Season

Month	Fishermen by Sample	Percent by Sample	Fishermen at Census Stations	Percent** at Census Stations	Fishermen in Study Area	Hours per Complete Effort	Hours of Fishing Effort	Catch per Hour	Catch
May	28	19.23*	146	68.75	212	2.45*	519	0.0217*	11
June	140	19.23	728	86.67	840	2.45	2,058	0.0217	45
July	441	25.98	1,697	80.67	2,104	3.53	7,427	0.0604	449
August	217	21.61	1,004	78.12	1,285	2.62	3,367	0.0219***	74
September	73	12.50	584	92.68	630	1.41	888	0.0219***	19
Totals	899		4,159		5,071		14,259		598

* From June data
** Same as for trout fishery
*** August and September data combined

APPENDIX TABLE IV A

Catfish Creel Census Summary
1948-49 Season

Month	Fishermen Contacted		Hours Fished	Catch	Efforts Complete	Hours Complete	Fishermen Seen	
	Parties c_1	Fishermen d_1					Parties c_2	Fishermen d_2
May	22	38	28.00	2	3*	4.50	**	
June	12	21	26.75	14	27*	55.25	**	
July	19	28	92.25	29	25*	64.25	2	2
August	9	18	19.75	5	12*	17.00	3	5
September	11	15	7.00	2	1	1.00	2	2
October	3	5	3.00	6	0	0	0	0
November	3	6	3.00	0	0	0	0	0
December	1	2	0	0	0	0	0	0
January	0		0	0	0	0	0	0
February	10	13	10.25	0	1	.75	1	1
Totals	90	146	190.00	58	69	142.75	8	10

* Census samples and complete census combined
** No record of parties in May and June

APPENDIX TABLE IV B

Catfish Fishermen by Creel Census Sample
1948-49 Season

Month	Sundays*					Week Days					Saturdays				
	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled	Fishermen Contacted and Seen	Parties Seen	Days Sampled	Days Month	Number of Fishermen Sampled
	a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.	a	b	x_1	x_2	T.F.S.
May	20	0	5	6	24.00	9	0	4	20	45.00	9	0	5	5	9.00
June	7	0	4	4	7.00	11	0	4	22	60.50	6	0	4	4	6.00
July	4	0	5	5	4.00	8	0	4	21	42.00	18	0	5	5	18.00
Aug.	11	0	5	5	11.00	8	0	5	22	35.20	4	2	4	4	7.83
Sept.	10	0	5	5	10.00	3	0	4	21	15.75	4	0	4	4	4.00
Totals	52	0	24	25	56.00	39	0	21	106	198.45	41	2	22	22	44.83

* National holidays included as Sundays
Formula shown in Appendix Table IB

Appendix Table IV C

Catfish Fishery
Analysis of Complete Efforts

1948-49 Season

Month	Hours of Sampling	Hourly Intervals	Fishermen Present at Hourly Intervals	Number of Fishermen Involved	Percent of Fishermen Present per Hour
		i	f	n	% F.P.
May	0630 - 1900	13	6	3	16.52*
June	0630 - 1930	13	52	24	16.52*
July	0600 - 2000	15	40	15	17.78
Aug.	0630 - 1930	13	18	12	11.83**
Sept.	0630 - 1845	12	2	1	11.83**
Totals			118	55	

* May and June data combined
** August and September data combined

Formula shown in Appendix Table IC

APPENDIX TABLE IV D

Catfish Fishery Analysis Sheet
1948-49 Season

Month	Fishermen by Sample	Percent by Sample	Fishermen at Census Stations	Percent*** at Census Stations	Fishermen in Study Area	Hours per Complete Effort	Hours of Fishing Effort	Catch per Hour	Catch
May	78	16.52*	472	68.75	687	1.99*	1,367	0.0714	98
June	73	16.52*	442	86.67	510	1.99*	1,015	0.5234	531
July	64	17.78	360	80.67	446	2.57	1,146	0.3144	360
August	54	11.83**	456	78.12	584	1.38**	806	0.2617**	211
September	30	11.83**	254	92.68	274	1.38**	378	0.2617**	99
Totals	299		1,984		2,501		4,712		1,299

* May and June data combined
** August and September data combined
*** Same as for trout fishery

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